ORIGINAL RESEARCH

Health Resource Utilization and Direct Costs Associated with Angina for Patients with Coronary Artery Disease in a US Managed Care Setting

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Background: Angina is often a first symptom of coronary artery disease (CAD); however, the specific burden of illness for patients with CAD-associated angina in managed care has not been reported.

Objective: To determine the clinical and cost burden of illness for patients with CAD-associated angina in a managed care environment.

Study design: A retrospective database analysis in a nationwide commercial managed care plan.

Methods: This study included patients with *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnostic or procedure codes for CAD between July 1, 2004, and June 30, 2006, who had data available for the period 6 months before and 12 months after the index date. The primary analyses for patients classified as having CAD with angina were based on a 3-algorithm patient-identification model (combined positive predictive value of 89%, 95% confidence interval, 0.79-0.95). Utilization measures for the 12-month postindex period, annual CAD-related direct costs, and total all-cause costs (ie, medical plus pharmacy) were determined. A generalized linear model was used to compare CAD-related costs and overall costs.

Results: Of the 246,227 patients with CAD, the 3-algorithm model assigned 230,919 patients (93.8%) to the CAD-without-angina cohort and 15,308 (6.2%) to the CAD-with-angina cohort. Patients with angina were more likely than patients without angina to be hospitalized (41% vs 11%, respectively; P <.001), to visit the emergency department (34% vs 12%, respectively; P <.001), to have office visits (94% vs 79%, respectively; P <.001), and to have more revascularization procedures (35% vs 8%, respectively; P <.001). Average CAD-related inpatient costs were \$9536 versus \$2169, and pharmacy costs were \$1499 versus \$891, for patients with and without angina, respectively. Total average CAD-related medical and pharmacy costs for patients with angina were \$14,851 versus \$4449 for patients with CAD without angina, and the average all-cause per-patient cost was \$28,590 versus \$14,334, respectively.

Conclusion: Based on these results, US patients with CAD plus angina in a managed care setting use significantly more healthcare services and incur higher costs than patients who have CAD without angina. Revascularization procedures are a major driver of these increased costs for those with CAD and angina.

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Disclosures are at end of text

hest pain, or angina pectoris, is the primary symptom of coronary artery disease (CAD), or chronic heart disease, a leading cause of morbidity and mortality in the United States. An estimated

17.5 million Americans have CAD, 9 million have angina pectoris, and approximately 500,000 new cases of angina are diagnosed annually.^{1,2} Current evidence-based treatment guidelines for patients with stable ischemic

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KEY POINTS

- ➤ Approximately 17.5 million Americans have coronary artery disease (CAD) and 9 million have angina, which is often the initial symptom of CAD.
- ➤ There are limited data on healthcare resource utilization and direct costs for patients with CAD plus angina, and CAD without angina.
- ➤ This study used real-world data to compare treatment patterns and costs for patients who have CAD with and without angina in a managed care setting.
- ➤ Average CAD-related inpatient costs were \$9536 for those with angina versus \$2169 without angina; total average CAD-related medical and pharmacy costs for patients with angina were \$14,851 versus \$4449 for those without angina.
- ➤ Overall, patients with CAD plus angina used considerably more healthcare resources than those without angina, including hospitalization, emergency department visits, outpatient visits, and cardiovascular drug regimens.
- ➤ In addition, patients with CAD and angina were significantly more likely to have a revascularization procedure—a major cost driver—than patients without angina.

heart disease recommend lifestyle changes, drug therapy, and revascularization procedures.^{3,4} Current treatment strategies are to identify and treat underlying conditions that may contribute to angina symptoms, modify risk factors, improve a patient's health and survival through pharmacologic and nonpharmacologic means, and utilize revascularization procedures through evidence-based practice.⁵

To date, several studies have examined resource utilization in patients with angina pectoris. These studies have examined the direct costs of chronic angina using national health statistics, as well as information in 2 large clinical trials—the COURAGE and MERLIN-TIMI 36 trials. However, no data exist comparing the manifestation of CAD with or without documented angina.

Few US studies have examined treatment patterns, resource utilization, and the cost of care for patients with CAD plus angina. Javitz and colleagues, who conducted the only database study to investigate the annual direct medical costs of chronic angina, reported annual costs ranging from \$1.9 billion to \$74.8 billion, depending on the way in which angina was defined.8 The study was conducted from a societal perspective, using the National Center for Health Statistics' publicuse databases. Given the considerable burden of stable ischemic heart disease and the paucity of information

about its economic impact, with particular emphasis in the public healthcare sector, the objective of the current study was to compare real-world treatment patterns and costs of CAD with angina versus CAD without angina in a large, commercially insured, managed care population.

Methods

Data Source

This large, retrospective database analysis used eligibility, medical, and pharmacy claims data from a nation-wide commercial managed care plan affiliated with OptumInsight that covers more than 13 million individuals. Procedures for selecting study participants were in compliance with the Health Insurance Portability and Accountability Act of 1996. 9.10 This study was approved by the privacy board associated with the New England Institutional Review Board.

Study Sample

Patients in the study population had physician or hospital claims between July 1, 2004, and June 30, 2006, that included *International Classification of Diseases*, *Ninth Revision*, *Clinical Modification (ICD-9-CM)* diagnostic, or ICD-9-CM Current Procedural Terminology (CPT), or Healthcare Common Procedure Coding System (HCPCS) procedure codes (in any position) consistent with a diagnosis of CAD (ICD-9-CM codes 410.xx, 411.x, 412, 414.xx, 429.2, 429.5, 429.6, 429.7x, 996.03, V45.81, V45.82; ICD-9-CM procedure codes 36.0x, 36.1x, 36.2, 36.3x; CPT codes 33140, 33141, 33510-33523, 33533-33536, 33572, 92975, 92996, 93540; or HCPCS codes G0290, G0291, S0340-S0342, S2205-S2209).

Eligible patients were enrolled in the plan for 6 months before receiving their *ICD-9-CM* code (ie, the index date) and for 12 months after the index date (ie, postindex period).

A subgroup of these patients was identified as having CAD with angina. Patient identification was based on 6 algorithms used in the study by Javitz and colleagues.⁸ After those algorithms were modified to be more reflective of the patient population in the current study, a medical chart review was conducted. This review determined the positive predictive value of each algorithm for identifying the greatest number of patient charts with an angina diagnosis relative to the total number of charts reviewed.

Stratification of the algorithms by their positive predictive values (**Table 1**) showed that 3 had high values (algorithms 1, 3, and 5: 80%-95%), 1 had an intermediate value (algorithm 2: 67%), and 2 had low values (algorithms 4 and 6: 52% and 25%, respectively).

The primary analyses for this study were based on a 3-algorithm patient-identification model (using algorithms 1, 3, and 5), which had a combined positive predictive value of 89% (95% confidence interval [CI], 0.79-0.95). Secondary analyses were based on a 4-algorithm model (using algorithms 1, 2, 3, and 5), which had a combined positive predictive value of 83% (95% CI, 0.73-0.90).

Patients were divided into 2 cohorts. The first cohort, consisting of patients with CAD with angina, included individuals who were identified by the 3-algorithm model (primary analyses) or by the 4-algorithm model (secondary analyses). The second cohort, consisting of patients with stable ischemic heart disease without angina, included patients who were identified by algorithms with an intermediate or low positive predictive value and those who were not identified by any of the algorithms.

Outcome Variables

Healthcare utilization and direct costs during the 12 months after the identification index date were determined for each patient in both cohorts. Utilization measures included the number of physician and other outpatient visits, emergency department visits, hospitalizations, and revascularization procedures, as well as the number of prescriptions filled. Annual CAD-related direct costs were measured for outpatient visits, hospitalizations, and pharmacy costs, and the total costs (medical plus pharmacy) were calculated. Total all-cause costs (medical plus pharmacy), including CAD-related and non-CAD-related costs, were also calculated. Costs were not consumer-price adjusted to the current year, and reflect the costs in the year in which the services occurred. Indirect costs were not evaluated, because such costs are not available in the database used.

Table 1 Assessment of Algorithms for Positive Predictive Value in Identifying Patients with Angina						
Algorithm	Description	Frequency, N (%)	Positive predictive value	95% CI		
1	2 angina diagnosesª and 2 nitrates (≥30-day gap)	5987 (13)	0.95	0.74-0.99		
2	2 angina diagnoses ^a and • 2 beta-blockers (≥30-day gap) or • 2 calcium channel blockers (≥30-day gap)	12,405 (28)	0.67	0.45-0.84		
3	1 angina diagnosis and 2 nitrates (≥30-day gap)	3246 (7)	0.80	0.59-0.93		
4	1 angina diagnosis and2 beta-blockers (≥30-day gap) or2 calcium channel blockers (≥30-day gap)	11,112 (25)	0.52	0.31-0.73		
5	 2 nitrates (30-150 days apart) and 2 CAD diagnoses^a and 2 chest pain diagnoses^a 	6075 (14)	0.95	0.75-0.99		
6	 nitrate and No angina diagnosis and No CAD diagnosis and No chest diagnosis and No hydralazine and isosorbide prescription filled within 90 days of each other 	5861 (13)	0.25	0.07-0.52		
1, 3, 5	Combination of 3 groups	15,308	0.89	0.79-0.95		
1, 2, 3, 5	Combination of 4 groups	27,713	0.83	0.73-0.90		
Total	All 6 groups	44,686		_		

^aPatients included in the study had 2 claims with a diagnosis in the ICD-9-CM primary or secondary position on different dates for any setting (other than laboratory) or 1 diagnosis in the primary position during an inpatient stay. CAD indicates coronary artery disease; CI, confidence interval; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.

Table 2	Demographic and Clinical Characteristics of the Study Population
	Study Population

Variable	CAD without angina (N = 230,919)	CAD with angina (N = 15,308)	P value ^a				
Age, yr, mean (SD)	59 (11.50)	61 (11.27)	<.001				
Age-group, N (%)							
35-44 yr	23,642 (10)	855 (6)	<.001				
45-54 yr	61,027 (26)	3630 (24)	<.001				
55-64 yr	86,324 (37)	6093 (40)	<.001				
≥65 yr	59,926 (26)	4730 (31)	<.001				
Gender, N (%)							
Male	145,230 (63)	10,037 (66)	<.001				
Female	85,689 (37)	5271 (34)	<.001				
CCI score, mean (SD)							
Baseline	0.81 (1.29)	1.30 (1.65)	<.001				
Follow-up	1.51 (1.80)	2.44 (2.16)	<.001				

^aP value for comparison between the CAD-without-angina and CAD-with-angina cohorts.

The extent of clinically significant comorbidity was determined using the Charlson comorbidity index (CCI).¹² A patient's CCI score reflects the cumulative increase in the likelihood of 1-year mortality as a result of severity of comorbidity, with higher scores indicating a greater risk for death. The CCI has been modified for use with administrative databases, including the ICD-9-CM database.^{13,14} CCI scores before and after a patient's index date were determined.

Statistical Analysis

All study variables, including baseline and follow-up measures, were analyzed descriptively using the SAS version 9.1.3 (SAS Institute, Cary, NC) data analysis system. Dichotomous variables were analyzed using chisquare tests, and continuous variables were compared using *t*-tests.

Healthcare costs of study participants were highly variable, with some accruing thousands and others accruing millions of dollars in costs. Therefore, a generalized linear model was used to compare CAD-related costs and overall costs between the cohort with CAD and angina and the group with CAD without angina.

The model controlled for the effect of other confounding variables, including age, sex, health plan region, CCI score, and measures of baseline utilization. A generalized linear model assuming a gamma distribution and using a log link was employed to estimate adjusted costs for the 2 cohorts. Generalized linear modeling was conducted using Stata version 9 (Stata Corporation, College Station, TX).

Results

Of 246,227 patients with CAD, the 3-algorithm model assigned 230,919 (93.8%) to the CAD-without-angina cohort and 15,308 (6.2%) to the CAD-with-angina cohort (**Table 2**). Patients identified as having angina were significantly older than, but not clinically differentiated from, those without angina (mean age, 61 vs 59 years, respectively; P < .001). Both cohorts had a preponderance of men, because women tend to have a lower incidence of CAD than men until more advanced age.¹⁵

In both cohorts, the mean CCI score was higher during the 12 months after the index date than in the 6 months before the index date, but baseline (preindex) and follow-up (postindex) CCI scores were significantly higher (P < .001) in patients with angina than in those without angina, suggesting an increased burden of comorbidity in patients with angina.

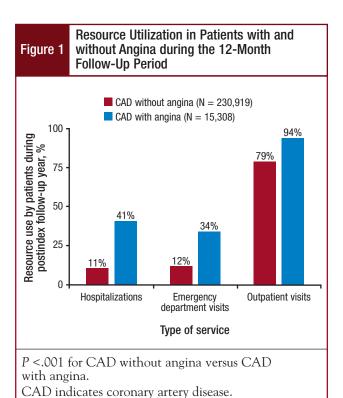
Resource Utilization

The CAD-with-angina cohort used considerably more resources than the cohort of patients with CAD without angina (Figure 1). Patients with CAD and angina were significantly more likely to be hospitalized (41% vs 11%, respectively; P < .001). Compared with 12% of patients with CAD without angina, 34% of those with angina visited the emergency department during the follow-up year (P < .001). The proportion of patients who visited a physician or other outpatient healthcare provider at least once during the follow-up period was 94% in the CAD-with-angina cohort and 79% in the CAD-without-angina cohort (P < .001), and the average number of outpatient visits was higher for patients with angina than for those without angina (6.7 vs 2.6 visits, respectively; P < .001).

Figure 2 shows the proportion of patients who received at least 1 prescription for cardiovascular medications during the follow-up period. Across all categories, patients who had CAD with angina were more likely to receive a prescription than those without angina.

Patients with CAD and angina had a significantly higher rate of revascularization procedures during the follow-up period than those without angina (35% [5288/15,308] vs 8% [19,466/230,919], respectively;

CAD indicates coronary artery disease; CCI, Charlson comorbidity index; SD, standard deviation.



Proportion of Patients with/without Angina Who Figure 2 Received at Least 1 Prescription for Cardiovascular Medication during Follow-Up Period \blacksquare CAD without angina (N = 230,919) CAD with angina (N = 15,308) 98% 100 90 85% Patients prescribed medication, 79% 80 70 60% 60 48% 50 44% 40 31% 29% 30. 20% 18% 17% 20-10 **Nitrates** Beta-ACE AT-II Calcium inhibitors lowering blockers receptor channel blockers blockers agents Medications

P <.001 for CAD without angina versus CAD with angina. ACE indicates angiotensin-converting enzyme; AT-II, angiotensin-II; CAD, coronary artery disease.

P <.001). Analysis of first revascularization interventions showed that percutaneous coronary intervention (PCI) or stent procedures were common in both cohorts, but that a significantly greater percentage of patients who had CAD with angina had such a procedure compared with those without angina (84% [4422/5288] vs 73% [14,300/19,466], respectively; P <.001). Among patients with CAD who had a revascularization procedure during the follow-up period, 57% (2994/5288) of the patients with angina compared with 53% (10,406/19,466) of those without angina had more than 1 procedure (data not shown in this article).

Direct Costs

The greater resource utilization by patients in the CAD-with-angina cohort is reflected in the direct costs of treating a patient with angina during the follow-up period. Comparison of 12-month CAD-related, perpatient costs showed that patients with angina had significantly higher costs than those without angina in all resource categories (**Figure 3**).

Average inpatient costs were higher for patients who had CAD with angina than for those without angina (\$9536 vs \$2169, respectively; P < .001). Emergency department and outpatient costs were also higher for patients with angina. Because patients who had CAD with angina were more likely to receive prescription

medication, average annual pharmacy costs were higher for patients with angina than for those without angina (\$1499 vs \$891, respectively; P < .001).

During the 12-month follow-up period, average medical and pharmacy costs were \$14,851 for patients who had CAD with angina compared with \$4449 for patients who had CAD without angina (P <.001). Comparison of all-cause total medical and pharmacy costs revealed a similar pattern. The average per-patient all-cause cost was \$28,590 for patients who had CAD with angina compared with \$14,334 for patients who had CAD without angina. This almost 2-fold increase in per-patient costs among patients with angina probably reflects the increased burden of comorbidity in this cohort.

The general linear model results in adjusted stable ischemic heart disease—related costs of \$4418 for CAD without angina and \$14,357 for CAD with angina. The adjusted all-cause costs were \$14,415 for CAD without angina and \$27,239 for CAD with angina (P < .001 for both).

Results Obtained with the 4-Algorithm Model

Although the patient cohorts identified by the 3-algorithm model were used for the primary study analyses, additional analysis based on the 4-algorithm model was conducted to assess the sensitivity of the results on cohort selection. Results based on the 4-algorithm model were similar to those obtained with the 3-algorithm

rithm model. For example, the proportion of patients with angina who had a revascularization procedure during the follow-up period was 35% using the 3-algorithm model and 34% using the 4-algorithm model.

Discussion

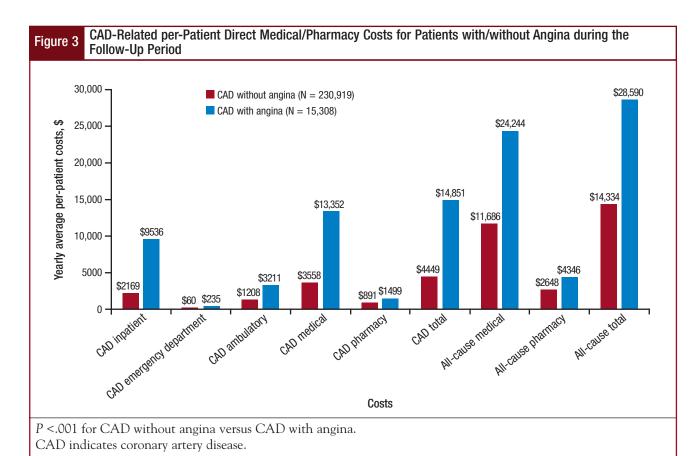
Whereas managed care pharmacy directors are often aware of the costs associated with managing CAD, they may not be as familiar with the additional incremental burden associated with angina. In evaluating therapies specifically for angina, this can be important information for making appropriate formulary decisions.

Our study shows that the CAD-with-angina cohort consumed more healthcare resources than the CAD-without-angina cohort, which is probably associated with an increase in the burden of comorbidities in this cohort. Compared with patients with CAD without angina, those with angina were more likely to be hospitalized, to visit the emergency department, to visit a physician or other outpatient healthcare provider, and to receive polypharmacy cardiovascular drug regimens. Similarly, patients who had CAD with angina were more likely than those without angina to have a first-time revascularization procedure or a first-time coronary

artery bypass graft. Both CAD-related and non–CAD-related medical and pharmacy costs were considerably higher in patients who had CAD with angina.

The implications of our study support that ischemic heart disease continues to account for the vast majority of cardiac disease, including hospitalizations for myocardial infarctions, unstable angina, and evaluation and treatment of stable chest pain syndromes. Of note, our study provides further evidence that patients with active symptoms remain at increased risk for morbidity, revascularization procedures, and polypharmacy, with a substantial increase in healthcare resource utilization compared with patients with CAD without angina.

Results similar to those obtained in this US-based study have previously been reported for studies conducted in the United Kingdom, 16,17 Sweden, 18,19 Switzerland, 20 Australia, 21 and Italy. 22 Although these studies showed that pharmacy costs and physician and emergency department visits contribute to the high and steadily growing annual healthcare costs of patients with chronic angina, the increasing use of revascularization procedures is the major contributor to these costs. This point is confirmed by the evaluation of the relative cost and cost-effectiveness of PCI compared with an optimal



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treatment strategy from the COURAGE trial.⁶ The addition of PCI to optimal medical therapy was not found to be a cost-effective initial management strategy for symptomatic chronic CAD.⁶

The findings of the present study are confirmed by a systematic review of 47 studies of the economic burden of illness for patients with CAD and angina, conducted by Reynolds and colleagues.²³ In addition to showing that revascularization procedures were the major determinant of healthcare costs for patients with chronic angina, that review suggested that these procedures had only a modest and transient beneficial effect on patients' work status.²³

In many studies, the increase in the proportion of patients who were employed 6 months to 1 year after revascularization was less than 25%, and the results of studies with multiyear follow-up periods suggested that most patients who initially returned to work were no longer employed within several years of the initial procedure. Planned departure from the workforce upon reaching retirement age seems to have had only a minor impact on patients' employment status.

Although our study did not directly address the indirect costs of CAD, those costs are important. Indirect costs of lost workdays, reduced productivity, and long-term medications may be as great as the direct costs measured by this present study, as suggested by Shaw and colleagues.²⁴

A more recent study—a substudy of the MERLIN-TIMI 36 trial investigating the economic impact of angina after acute coronary syndrome (ACS)—showed that patients with CAD plus angina had a >2-fold increase in resource utilization and an additional \$4000 in incremental costs at 8 months of follow-up after an ACS event.⁷ The difference was mostly attributable to higher rates of hospitalization and revascularization procedures among patients admitted for ACS with more severe angina.

The magnitude of this problem is estimated to be in the tens of billions of dollars.

In our database study, we used a rigorous methodology to identify patients with angina. We hypothesized that identifying patients in a claims database would be challenging for several reasons. For example, physicians may use angina codes during the screening of patients eventually found to have other causes of chest discomfort, and various *ICD-9-CM* diagnostic and medication codes are routinely used for patients with angina. Although the use of managed care claims data is attractive, because it shows real-world practice patterns, it does not explain why clinicians selected a particular code for a diagnosis or medication, nor does it permit an assessment of the accuracy of these codes for identifying a specific disease.

A typical method for identifying a patient with a particular disease in a claims database is to find 2 separate events with a primary *ICD-9-CM* disease diagnostic code combined with at least 2 claims with the medication code for the drug most often used to treat that disease. When we considered the best approach for identifying patients with angina, we realized that this symptom could be described as either "angina" or "chest pain." Although nitrates are the primary drug treatments for angina, many other medications may also be prescribed. We therefore assumed that we would fail to identify a large proportion of patients with angina if we used only the diagnostic code for angina and the medication codes for nitrates.

To increase the likelihood of obtaining a representative sample of patients with angina, we examined the algorithms used in the study by Javitz and colleagues, modified them to reflect the composition of our database, and based on the results of a medical chart review, stratified the 6 algorithms according to their positive predictive value. We then defined our 2 study cohorts using a model that incorporated the 3 algorithms with the highest positive predictive value (a combined value of 89%), although we performed some secondary analyses using a 4-algorithm model with a combined positive predictive value of 83%.

When we compared the outcomes of patients identified as having angina by the 3- and 4-algorithm models, we observed only minor differences. Both models revealed significantly higher rates of resource utilization and significantly higher CAD-related and non–CAD-related direct costs for patients with angina than for those without angina. The 3-algorithm patient-identification model was chosen because of its higher positive predictive value, indicating that the 3-algorithm model selects patients with true angina with a higher probability than other algorithms.

We found that the outcome measures we used were essentially unrelated to the slightly different definitions of angina in the 2 models, adding to the robustness of our findings. Therefore, in the 3-algorithm model used in this article, 35% of angina patients underwent revascularization compared with 34% in the 4-algorithm model.

Limitations

This study shares the limitations inherent to all administrative claims studies. Claims data are collected for the purpose of determining reimbursement rather than of facilitating research, and the extent to which these data can accurately capture a diagnosis is limited.²⁵⁻³⁴ In contrast, claims data provide a snapshot of a real-world treatment environment based on the actual use of healthcare resources and their costs. Admin-

istrative data have demonstrated reasonably good concordance with medical record or patient survey data.²⁵⁻³⁵ The cause of the incremental cost differences is difficult to assess; for example, some of the increased burden associated with patients who have CAD with angina may be because of increased physician contact and services resulting from the additional diagnosis, and not specifically from angina.

The results of this study can be generalized only to a limited extent. The managed care database on which the study was based represents a population of commercially insured patients. Therefore, these patients are relatively younger (ie, non-Medicare population), with a lower burden of comorbidity than would typically be found in databases of Medicare recipients.

The results of this study are relevant to the treatment of cardiovascular disease in a managed care setting.

Conclusion

This study demonstrates that among commercially insured US patients diagnosed with and treated for CAD in a managed care setting, patients with angina make significantly greater use of healthcare resources than patients without angina. In the year after their CAD diagnosis, patients with angina are considerably more likely to have a revascularization procedure than those without angina. This greater resource utilization, if not based on evidence-based practice, may result in significantly higher annual direct costs for patients with angina. Additional analyses are warranted to further evaluate the impact of these findings as they relate to medical practice and pharmacy services, perhaps via prospective trial designs and/or observational research.

The pattern of healthcare utilization observed in this study suggests that patients with angina may seek care, obtain incomplete relief of their symptoms, and then continue to seek care. For patients treated in a managed care environment, therapeutic approaches that are consistent with current treatment guidelines and reduce the frequency and severity of angina attacks could result in substantial savings in terms of resource usage and direct economic costs in managed care organizations.

Acknowledgment

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Author Disclosure Statement

Dr Kempf was employed by CV Therapeutics (Gilead) when this article was written; Ms Buysman is an employee of OptumInsight, which was contracted by CV Therapeutics (Gilead) to conduct this research; Dr Brixner has received consultant support for this research.

References

- 1. Lloyd-Jones D, Adams RJ, Brown TM, et al, for the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2010 update: a report from the American Heart Association. Circulation. 2010;121:e46-e215. Erratum in Circulation. 2010;121:e260.
- 2. Mensah GA, Brown DW. An overview of cardiovascular disease burden in the United States. *Health Aff (Millwood)*. 2007;26:38-48.
- 3. Gibbons RJ, Abrams J, Chatterjee K, et al, for the American College of Cardiology and American Heart Association Task Force on practice guidelines (Committee on the Management of Patients With Chronic Stable Angina). ACC/AHA 2002 guideline update for the management of patients with chronic stable angina—summary article. *J Am Coll Cardiol.* 2003;41:159-168.
- **4.** Fraker TD Jr, Fihn SD, Gibbons RJ, et al, for the American College of Cardiology, American Heart Association, and American College of Cardiology/American Heart Association task force on practice guidelines writing group. 2007 chronic angina focused update of the ACC/AHA 2002 guidelines for the management of patients with chronic stable angina. Circulation. 2007;116:2762-2772. Epub 2007 Nov 12.
- **5.** Lucas FL, DeLorenzo MA, Siewers AE, Wennberg DE. Temporal trends in the utilization of diagnostic testing and treatments for cardiovascular disease in the United States, 1993-2001. *Circulation*. 2006;113:374-379.
- **6.** Weintraub WS, Boden WE, Zhang Z, et al, for the Department of Veterans Affairs Cooperative Studies Program No. 424 (COURAGE Trial) investigators and study coordinators. Cost-effectiveness of percutaneous coronary intervention in optimally treated stable coronary patients. Circ Cardiovasc Qual Outcomes. 2008;1:12-20.
- 7. Arnold SV, Morrow DA, Lei Y, et al. Economic impact of angina after an acute coronary syndrome: insights from MERLIN-TIMI 36 trial. Circ Cardiovasc Qual Outcomes. 2009;2:344-353. Epub 2009 Jun 2.
- 8. Javitz HS, Ward MM, Watson JB, Jaana M. Cost of illness of chronic angina. Am J Manag Care. 2004;10(suppl 11):S358-S369.
- 9. Health Insurance Portability and Accountability Act of 1996. Public Law No. 104-191, 110 Stat 1936;1996. www.cms.gov/hipaageninfo/downloads/hipaalaw.pdf. Accessed September 13, 2011.
- 10. Gunn PP, Fremont AM, Bottrell M, et al. The Health Insurance Portability and Accountability Act privacy rule: a practical guide for researchers. *Med Care.* 2004; 42:321-327.
- CDC. Coding Clinic for ICD-9-CM: Official Guidelines for Coding and Reporting. www.cdc.gov/nchs/data/icd9/icd9cm_guidelines_2011.pdf. Accessed September 13, 2011.
- 12. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987:40:373-383.
- 13. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992;45:613-619.
- Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005;43:1130-1139.
 Vaccarino V, Parsons L, Every NR, et al. Sex-based differences in early mortality after myocardial infarction. National Registry of Myocardial Infarction 2 Participants. N Engl J Med. 1999;341:217-225.
- 16. Stewart S, Murphy NF, Walker A, et al. The current cost of angina pectoris to the National Health Service in the UK. *Heart*. 2003;89:848-853.
- 17. Sculpher M, Smith D, Clayton T, et al. Coronary angioplasty versus medical therapy for angina. Health service costs based on the second Randomized Intervention Treatment of Angina (RITA-2) trial. Eur Heart J. 2002;23:1291-1300. 18. Andersson F, Kartman B. The cost of angina pectoris in Sweden. Pharmacoecomomics. 1995;8:233-244.
- 19. Zethraeus N, Molin T, Henriksson P, Jönsson B. Costs of coronary heart disease and stroke: the case of Sweden. *J Intern Med.* 1999;246:151-159.
- 20. Claude J, Schindler C, Kuster GM, et al, for the Trial of Invasive versus Medical therapy in the Elderly (TIME) investigators. Cost-effectiveness of invasive versus medical management of elderly patients with chronic symptomatic coronary artery disease. Findings of the randomized trial of invasive versus medical therapy in elderly patients with chronic angina (TIME). Eur Heart J. 2004;25:2195-2203.
- **21.** Calver J, Brameld KJ, Preen DB, et al. High-cost users of hospital beds in Western Australia: a population-based record linkage study. Med J Aust. 2006;184:393-397.
- 22. Conti A, Pieralli F, Sammicheli L, et al. Updated management of non-ST-segment elevation acute coronary syndromes: selection of patients for low-cost care: an analysis of outcome and cost effectiveness. *Med Sci Monit.* 2005;11:CR100-CR108.
- 23. Reynolds MW, Frame D, Scheye R, et al. A systematic review of the economic burden of chronic angina. *Am J Manag Care*. 2004;10(suppl 11):S347-S357.
- 24. Shaw LJ, Merz CN, Pepine CJ, et al. The economic burden of angina in women with suspected ischemic heart disease: results from the National Institutes of Health—National Heart, Lung, and Blood Institute—sponsored Women's Ischemia Syndrome Evaluation. *Circulation*. 2006;114:894-904. Epub 2006 Aug 21.
- **25.** Rawson NS, Malcolm E. Validity of the recording of ischaemic heart disease and chronic obstructive pulmonary disease in the Saskatchewan health care datafiles. *Stat Med.* 1995;14:2627-2643.
- **26.** Humphries KH, Rankin JM, Carere RG, et al. Co-morbidity data in outcomes research: are clinical data derived from administrative databases a reliable alternative to chart review? *J Clin Epidemiol*. 2000;53:343-349.

27. Romano PS, Roos LL, Luft HS, et al. A comparison of administrative versus clinical data: coronary artery bypass surgery as an example. Ischemic Heart Disease Patient Outcomes Research Team. J Clin Epidemiol. 1994;47:249-260.

28. Jollis JG, Ancukiewicz M, DeLong ER, et al. Discordance of databases designed for claims payment versus clinical information systems: implications for outcomes research. *Ann Intern Med.* 1993;119:844-850.

29. Dans PE. Looking for answers in all the wrong places. Ann Intern Med. 1993;119:855-857.

30. Jollis JG. Utility and limitations of claims data [letter]. Ann Intern Med. 1994;120:1049-1051.

31. Muhajarine N, Mustard C, Roos LL, et al. Comparison of survey and physician claims data for detecting hypertension. *J Clin Epidemiol*. 1997;50:711-718.

32. Fowles JB, Lawthers AG, Weiner JP, et al. Agreement between physicians' office records and Medicare Part B claims data. *Health Care Financ Rev.* 1995;16:189-199. 33. Quan H, Parsons GA, Ghali WA. Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. *Med Care.* 2004;42:801-809.

34. Quan H, Truman C, Jin Y, Ghali WA. Combination of hospital discharge and physician claims data improves detection of procedures. Presented at the AcademyHealth Annual Research Meeting, June 26-28, 2005; Boston, MA. Abstract 3388.

35. Tang PC, Ralston M, Årrigotti MF, et al. Comparison of methodologies for calculating quality measures based on administrative data versus clinical data from an electronic health record system: implications for performance measures. *J Am Med Inform Assoc.* 2007;14:10-15. Epub 2006 Oct 26.

STAKEHOLDER PERSPECTIVE

Medical Claims Data Can Inform Coverage Decisions in Managed Care Health Plans

RESEARCHERS: Actionable information within a healthcare setting is predicated on access to data and analyses relevant to patients and healthcare providers in that setting. The original research by Kempf and colleagues in this article provides a superb example of exploiting an administrative claims database to inform decisions regarding coverage and program design in patients with coronary artery disease (CAD) with or without angina in a nationwide commercial managed care plan.

Richly annotated, the article provides excellent descriptions of case ascertainment procedures within the limitations of a claims database, develops a coherent analytic model for adjusted analyses, and evaluates the impact of alternative methods of analyses on results and conclusions. The authors' examination of the challenges associated with administrative claims research using this study as a model is particularly instructive. The precautionary note regarding generalization of results beyond the demographic of participants in a commercial managed care setting within the United States is laudable.

PAYERS: Even with adjustments controlling for confounding variables, physician and other outpatient visits, emergency department visits, hospitalizations, revascularization procedures, and prescription medication differ significantly and appreciably between patient cohorts. Particularly notable, the increase in all-cause direct medical and pharmacy costs driven by revascularization procedures and increased physician contact in CAD patients with angina is corroborated by analyses conducted internationally, as well as by results from substudies in prospective interventional research. Convergent observations across study designs

and geographic locations emphasize the methodologic rigor that characterizes this study and reinforce the importance of aggressive management of active symptomatology in the treatment of patients with stable chest pain syndromes.

The data strongly suggest that programmatic interventions may be most effective in the year after initial CAD diagnosis, and they generate testable hypotheses regarding day-to-day angina self-management skills for future inquiry.

PATIENTS: The analyses do not address direct (out-of-pocket) costs incurred by patients with CAD with and without angina. However, both indirect (time-related) and direct costs incurred by patients and family members resulting from increased contacts with healthcare providers and utilization of other healthcare resources can be deduced from the conclusions of the study. These include adverse impacts on leisure and household work activities, as well as on workplace attendance and productivity resulting from an increased frequency of physician contact on the part of patients with CAD who obtain incomplete symptom relief, and therefore, repetitively seek medical care and eventually require procedural intervention for symptom control.

The results of this study also heighten awareness regarding the importance of self-management education activities, including medication, exercise/diet, symptom monitoring, and particularly, decisions about seeking emergency medical assistance.

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